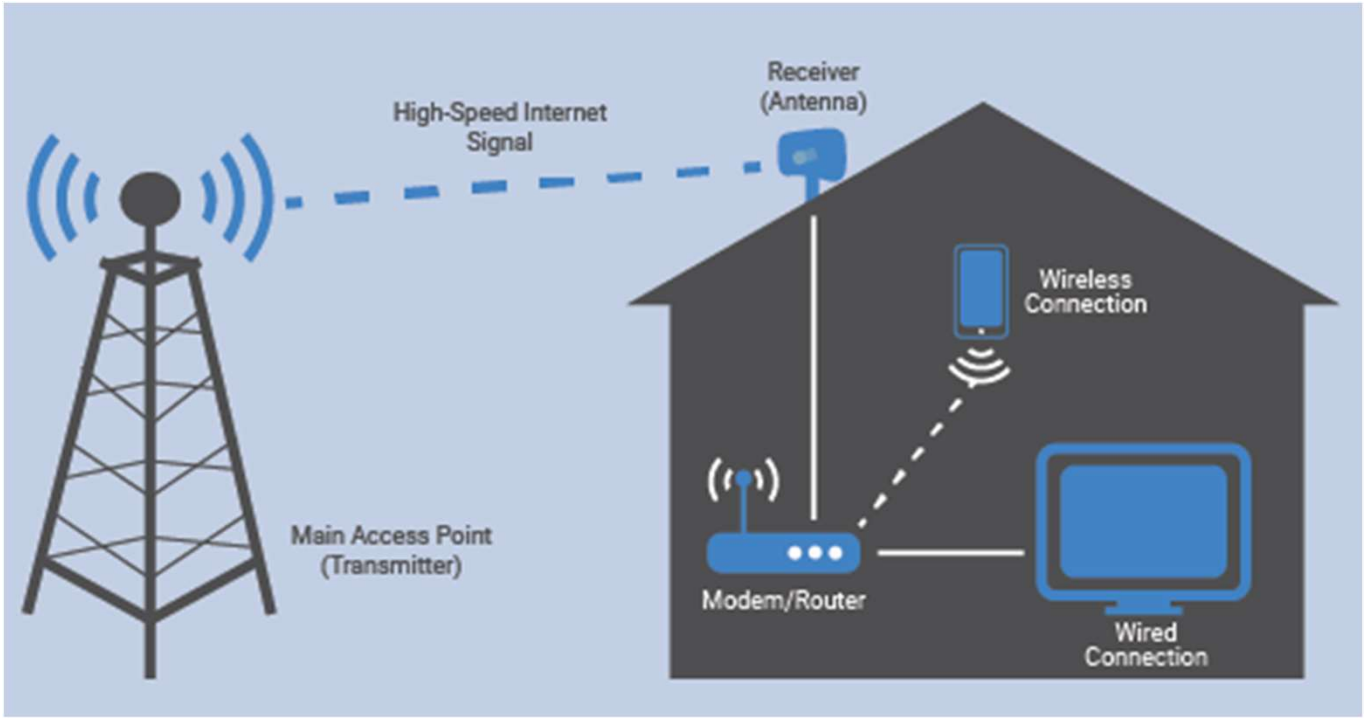
AP&T's experience deploying and maintaining fixed wireless service in rural Alaska.

Fixed Wireless



Who is AP&T?

Alaska Power & Telephone

- Established in Alaska 1957.
- We are employee-owned energy utility and telecommunications provider with approximately 140 employee/owners.
- We are traded over-the counter “APTL”

Energy

- We operate microgrids in rural and remote areas of Alaska.
- Distribution, Transmission and Generation
- We plan, construct and operate all aspects of an electrical system. 80%+ of our energy comes from renewable resources primarily hydro.
- Most recent project was Hiilangaay on Price of Wales Island.
- https://vimeo.com/363431514/cd873345b0

Telecom

- Local exchange carrier providing voice services. (LEC)
- Broadband providing service over fiber, copper and wireless in the last mile.
- We have constructed middle mile fiber terrestrially and submerged. Our newest project scheduled for completion in 2022 – 2023 is SEALink.

Fixed Wireless

- **Licensed and Unlicensed Spectrum**
  - Licensed spectrum
    - Higher power radio
    - Less interference
    - Typically fewer equipment manufacturers
  - Unlicensed spectrum
    - Lower power radios
    - Often has more risk of interference
    - Typically has a wide range of equipment manufacturers
- **Wide Range of Frequencies**
  - 900MHz – Unlicensed
  - 2.4GHz – Unlicensed
  - 2.5GHz – Licensed (Rural Tribal Spectrum and future commercial service)
  - 3GHz – Licensed and Unlicensed (Citizens Broadband Radio Service (CBRS))
  - 5GHz – Unlicensed
  - LTE – Licensed
- **Point to Multipoint**
  - One or more Access Points communicating with many subscriber units
  - Not point to point (microwave)
- **Primary use case is last mile**

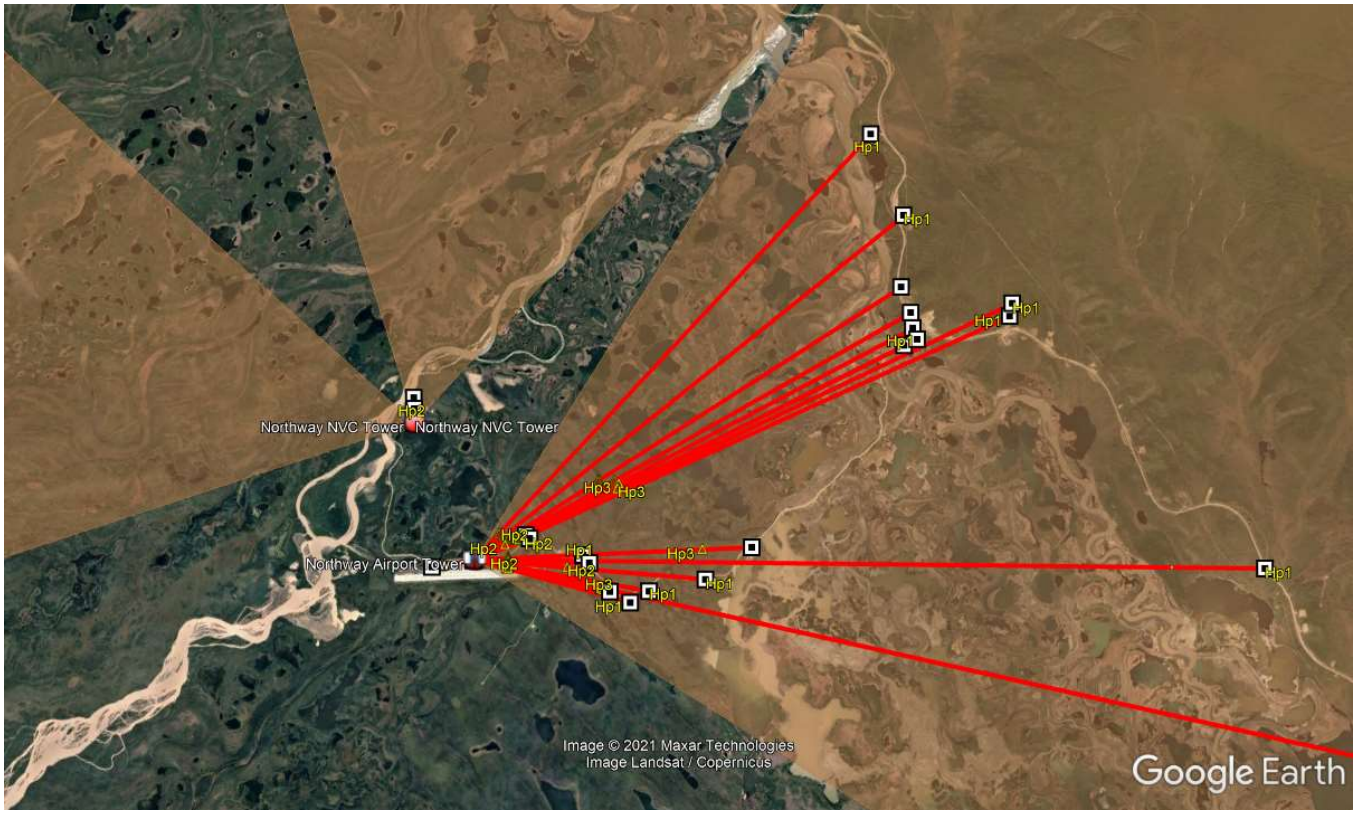
Advantages and Potential Drawbacks of Fixed Wireless

- **Advantages**
  - Deployment is usually cost effective
    - Copper
    - Fiber
    - Satellite
  - Typically faster to deploy than copper or fiber
- **Potential Drawbacks**
  - Maintenance costs can be high
    - Radio Frequency bandwidth is a finite resource
    - First customer may have great service, but by the time the 50th customer is added service may be very poor
    - Adding additional Access Points may create interference
    - Finding and identifying issues can be time consuming
    - Finding and mitigating interference can be an extremely frustrating experience
  - Fixed Wireless networks historically have a shorter lifespan than facility based networks
  - Bandwidth is limited
  - Some customers may have good service, others may not

AP&T's Experience

- **Southeast Alaska**
  - Terrain is a tremendous challenge
    - Mountains, Trees, and lots of Rain
    - These conditions made service extremely challenging
  - Sites Deployed between 2006 and 2008
    - Kasaan
    - Klawock (shutdown in 2020)
    - Thorne Bay (shutdown in 2021)
- **Northway Alaska**
  - Interior Alaska terrain is still a challenge, but much better
  - Cold

Northway, Alaska



Northway, Alaska

- **Frequency**
  - 900MHz
  - Better propagation
  - Limited Frequency (902MHz – 928MHz)
- **Equipment**
  - Waverider – Original
    - Limited to 8M per access point
    - Indoor Radio Units at each customer's home
  - Cambium – Today
    - 54M/13M per access point (advertised), 25M/7.5M more common
    - Outdoor Radio Units at each customer's home
    - Longest shot: ~9.2 miles
    - Best connection: 39M/10M
    - Worst connection: 13M/4M
    - Connections per Access Point: 6-34
    - Long Distance and poor signal connections reduce the overall effectiveness of an Access Point

Customer Equipment

Yagi Antenna Mounted on the customer house

Gain: 12db

Dimensions: 43.7” x 7.1” x 7”

Subscriber unit mounted to Antenna

Dimensions: 11” tall x 3.5” wide x 2” deep

Access Point

60 Degree Sector Antenna

Gain: 13db

Dimensions: 34.6” tall x 11.3” wide x 5.2” deep

Access Point mounted to Antenna

Dimensions: 10.3” tall x 5.3” wide x 3.3” deep

Construction Challenges

- **Access Point Site Selection**
  - Need Elevation!
  - Maximize access to customers
  - Site limitation
    - Land availability
    - Tower Height
- **Customer Installations**
  - Finding a place to mount the antenna on the house that has a path to the Access Point
  - Protecting from the elements (snow and ice)
  - Metal roofs can create problems (interference, ice shedding)

Operational Challenges

- **Radio Frequency (RF) Signal Levels**
- **Interference**
  - Modulation Levels
- **Frequency availability**
- **Access Point throughput**
- **Not enough Access Points**
- **New customer location causing issues with an existing customer**
- **Truck Rolls!**

Final Thoughts

- **Verify all Marketing Claims**
- **Start with a good RF Design**
  - Keep growth in mind
  - Select the Frequency or Frequencies that will provide the best service
  - Select Access Point Sites Carefully
- **Select good equipment**
  - Rugged enough to withstand Alaska environment
- **Find good installers**
  - Understand how to protect from weather
  - Understand the technology enough to find the best locations at customer's house
- **Plan for on-going troubleshooting and system optimization**